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6. AUTHOR(S)
Thomas L. Hayward

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)
Scripps Institution of Oceanography, Marine Life Research Group
9500 Gilman Drive
La Jolla, CA 92093-0227

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
Attn: Dr. James Eckman, 322BC
800 North Quincy Street
Arlington, VA 22217-5000

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13. ABSTRACT (Maximum 200 words)
This project was aimed at better defining the linkages between physical structure and ecosystem structure in the California Current with the goal of improving our ability to predict pattern in plankton distributions based upon models of ocean circulation. We used an empirical approach of analyzing large data sets to see which aspects of physical structure were best correlated with biological structure. We collected and analyzed new data with a continuous underway mapping system to examine mesoscale structure, and we analyzed historical data to examine seasonal, interannual and decadal time scales. We showed that the front at the inner edge of the California Current is an important boundary and that knowledge of the location of this feature has useful predictive value. We developed a better understanding of regional pattern in the relation between nearsurface T/S structure and the chlorophyll distribution. We showed that simple trophodynamic models may be insufficient to explain linkages between physical structure and plankton abundance on decadal time scales.

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Linkages between physical structure and primary production in the California Current

Thomas L. Hayward
Marine Life Research Group
Scripps Institution of Oceanography
La Jolla, California 92093-0227

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The overall goal of this project is to improve our ability to predict biological structure based upon information about physical structure. This is based upon the belief that sampling systems and models which predict physical structure are being developed more rapidly than biological samplers or models. We have used an empirical approach to determine what aspects of physical structure have the greatest predictive value about biological structure, and we have looked at a range of scales because the nature of the linkages may be scale dependent.

Patterns of primary production and phytoplankton abundance in the ocean are obscured by the great spatial and temporal variability. We are attempting to better resolve spatial pattern by developing and applying a continuous underway mapping system. We are attempting to better resolve temporal pattern by additional shipboard sampling and analysis of coastal shore station data and model output to fill in the gaps between shipboard surveys. We have shown that physical structure which determines the nutrient distribution and advection are the two main determinants of phytoplankton abundance in the California Current. We are now attempting to determine which specific aspects of physical structure have the most direct effect upon phytoplankton abundance. Prediction is hindered by our ability to predict either physical or biological structure, and by our limited understanding of how physical and biological structure are linked. We expect that progress will come most rapidly in predicting physical structure. We are thus attempting to predict the patterns of phytoplankton given predictions of physical structure. A major objective of this project is identify those specific aspects of physical structure which can be modeled or remotely sensed which have the most predictive value about the phytoplankton distribution. Identifying these properties should have value in focusing observational and modeling efforts in support of biological objectives and in improving our ability to describe and predict biological structure.

Analysis of continuous underway data has focused upon testing predictions based upon the expected linkages between physical and biological structure (e.g., the temperature-nitrate relation and the temperature-chlorophyll relation). The finding of some unexpected patterns (e.g., high chlorophyll at temperatures where nitrate is not expected to be present) has led to a better understanding of the regional nature of the linkages between physical and biological structure. Analysis of historical data indicates that the linkages between physical and biological structure also depend upon the temporal scale of physical forcing. This analysis has focused upon mesoscale, seasonal, and

interannual to decadal scale forcing. It is not clear that linkages determined on one space-time scale will apply to others, and we are determining to what extent linkages are scale dependent. Collaborations with programs developing physical models of the regional circulation will lay the groundwork for making predictive models of ecosystem structure.

We have completed development of a data processing scheme for the continuous underway mapping system and have improved the reliability of data logging software. Work is continuing on a data management scheme and processing data from past cruises. A manuscript on the continuous underway data and linkages between physical and biological structure is in press. We have provided interpretation of CalCOFI and other regional data in support of ONR projects collaborating with the CalCOFI program. We have collected and processed continuous underway data on an additional series of cruises (shiptime and hydrographic data collection supported by UC resources and NOAA) which give use monthly coverage of a subset of the CalCOFI grid during the El Niño period from October 1997 to January 1999. We have gathered the historical chlorophyll data from the California Current region for comparison with the hydrographic and macrozooplankton time series.

Analysis of a 4-year time series of continuous underway data in the context of hydrographic data shows that there is a variable relation between nearsurface physical structure (temperature, salinity) and chlorophyll in different subregions of the California Current. The boundaries of these subregions (regimes) can be identified based upon physical structure. Analysis of the hydrographic data gives insights into the differing types of physical forcing which determine phytoplankton abundance in each subregion. Analysis of the chlorophyll time-series does not show the same large decline since the mid-1970s as has recently been documented for macrozooplankton biomass. Although the chlorophyll time series has many fewer data points and it is not as long as the macrozooplankton time series (chlorophyll began as a routine measurement in 1984), this leads to the question of whether climate change affects the lower trophic levels in the California Current via bottom-up forcing. Analysis of the monthly coverage during the El Niño period shows that vertical temperature structure and the mesoscale circulation patterns can change very rapidly in the region. Changes in the circulation pattern can be predicted from mesoscale resolving models when properly initialized with regional data. Pattern in biological structure is strongly related to pattern in physical structure.

The observation that nearsurface physical-biological coupling is region specific and that the boundaries between regions can be identified based upon physical structure, means that it may be possible to start developing region-specific models linking physical and biological structure. The observation of rapid changes in physical and biological structure in this system illustrates the potential value of mesoscale resolving physical models in predicting biological structure. Uncertainty about whether the decline in macrozooplankton biomass is due to bottom-up forcing further illustrates the need to better understand the processes linking physical and biological structure.

This project is strongly interconnected with several other projects supported by ONR and other federal and state agencies. The CalCOFI program provides the sampling

opportunity to collect the continuous underway data and much of the supporting data used in this analysis. This project has benefited from additional sampling to study the effects of El Niño in the California Current supported by UC and NOAA. We have provided hydrographic and underway data to several programs.

Publications:

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